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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P511093PCT	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/GB2004/000923	International filing date *(day/month/year)* 05.03.2004	Priority date *(day/month/year)* 06.03.2003
International Patent Classification (IPC) or national classification and IPC H01F41/04		
Applicant COATED CONDUCTORS CONSULTANCY LTD et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 8 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 9 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☒	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
06.01.2005	26.08.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Stichauer, L Telephone No. +31 70 340-1959

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/000923

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-3, 5-40	as originally filed
4	received on 27.05.2005 with letter of 27.05.2005
Claims, Numbers	
1-43	received on 27.05.2005 with letter of 27.05.2005
Drawings, Sheets	
1/11-4/11, 6/11-10/11	received on 19.05.2004 with letter of 18.05.2004
Drawings, Figures	
4, 9	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/000923

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 4

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☒ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. 4 are so unclear that no meaningful opinion could be formed *(specify)*:

see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos.

☐ the nucleotide and/or amino acid sequence listing does not comply with the standard provided for in Annex C of the Administrative Instructions in that:

the written form
- ☐ has not been furnished
- ☐ does not comply with the standard

the computer readable form
- ☐ has not been furnished
- ☐ does not comply with the standard

☐ the tables related to the nucleotide and/or amino acid sequence listing, if in computer readable form only, do not comply with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions.

☒ See separate sheet for further details

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-3,5-29,33-41,43
	No:	Claims	30-32,42
Inventive step (IS)	Yes:	Claims	1-3,5-29,33-41,43
	No:	Claims	30-32,42
Industrial applicability (IA)	Yes:	Claims	1-3,5-43
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1 *Claim 4*

The amendments filed with the letter dated 27.05.2005 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following: claim 4 defines a choosing step (if an inhomogeneity develops in the calculation) without specifying, however, that such a choosing step is defined in the description (see e.g. p. 28, lines 20-21) only for subsequent layers.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

2 Reference is made to the following document:

D1: US-A-5 912 211 (YAMAZAKI SHUNPEI) 15 June 1999 (1999-06-15)

The document D1 is regarded as being the closest prior art to the subject-matter of claims 1, 34 and 43, and shows (the whole document):

"*a method of fabricating a track in a layer of thin film material for use in a superconducting coil, the layer provided on a former having a substantially curved surface*" (claims 1 and 43)

and

"*apparatus for fabricating a track, the track being formed in a layer of thin film material for use in a superconducting coil, the layer provided on a former having substantially curved surface, the track being cerated by defining a path into the layer*" (claim 34)

The subject-matter of claims 1 and 43 differs from this known method in that said method comprises steps (i)-(vi) (claim 1) or (i)-(vii) (claim 43).

The subject-matter of claim 34 differs from this known apparatus in that said apparatus comprises parts a) - d) .

The subject-matter of claims 1, 34 and 43 is therefore new (Article 33(2) PCT).

3 The problem to be solved by the present invention may be regarded as ***how to locate and repair (or avoid) defects in the coil track.***

The solution to this problem proposed in claims 1, 34 and 43 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons: a method is provided which detect defects, determine their nature (reparable or not), calculate an optimal path and define said optimal path to create the coil track (claims 1 and 43). Moreover, an apparatus suitable for carrying out said method is provided (claim 34).

4 Claims 2-3, 5-29 and 33 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Claims 35-41 are dependent on claim 34 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

5 Claims 30-31, 32 and 42 are indeterminate (see sections 6 and 7 of this communication for further details) and hence also devoid of novelty and inventive step (Art. 33(2), (3) PCT).

Re Item VIII

Certain observations on the international application

6 *Claims 30-31*

Claim 30 is an independent claim to a "*computer program or suit of computer programs* ". It broadly defines the feature "*computer program* " in terms of its intended use ("*computer program or suit of computer programs being arranged such that...*") . Hence, claim 30 lacks clarity in the sense of Article 6 PCT. See eventually present description, page 12, lines 24-32.

Similarly, independent claim 31 defines the feature "*computer-readable storage medium* " in terms of its intended use ("*storing the computer program... of claim 30*"). Hence, claim 31 lacks clarity in the sense of Article 6 PCT.

7 *Claims 32 and 42*

Claim 32 is an independent claim to an apparatus. However, no apparatus features are defined in claim 32, except the intended use ("*being arranged to carry out the method...*") . Hence, claim 32 lacks clarity in the sense of Article 6 PCT.

Independent claim 42 is directed to a device. However, a "**product-by-process**" definition is used ("*device fabricated by way of a method...*") , omitting to specify any distinctive device features. Hence, claim 42 does not meet requirements of the Article 6 PCT.

8 In order to prevent a terminological confusion, it would be preferable to use wording "*create/provide... coil track* " ; see claims 1, 34 [preamble and part d)] and 43. See p. 3, l. 13 ("*creating* ") and p. 29, l. 28 ("*providing* ").

9 It would appear more appropriate to file claim 17 as dependent on claim 15 (see originally filed claim 18), claim 18 as dependent on claim 14 (see originally filed claim 19) and claim 21 as dependent on any one of claims 14-**20** (typing error).

10 Claims 29 and 33 seem to relate to the same subject matter. It would be appropriate to abandon the claim 29 and, for purpose of clarity, to amend the claim 33 [part a)] e.g. as follows:

"*a) depositing, shaping and texturing,* ***in situ,*** *the material comprising the layer* ".

See also claim 41 (originally filed claim 36).

11 For purpose of clarity, the claim 34 should be reformulated as follows (only relevant parts are given):

(4) ... to identify and locate each defect in the layer ***to provide a map of the defect(s) present in the layer*** (see originally filed claim 31);

move (7) from its actual position to a position immediately after (4): see originally filed claim 33, dependent on the originally filed claim 31;

(7) to direct ... ***map of the defect(s)*** *to the memory for storage (see originally file claim 31).*

Claims

1. A method of fabricating a track in a layer of thin film material for use in a superconducting coil, the layer provided on a former having a substantially curved surface, the method comprising the steps of:

(i) scanning the layer to detect defects in the layer by probing a physical property of the material comprising the layer, without the coil path being defined in the layer, to provide a data set of said physical property;

(ii) processing the data set to form a map having features indicating variations in the said physical property over the layer;

(iii) analysing the features of the map to identify and locate defects in the layer;

(iv) identifying whether each defect is irreparable;

(v) calculating an optimal path so as to avoid the irreparable defect(s); and

(vi) defining the optimal path in the layer to define the coil track.

2. A method as claimed in claim 1, wherein the method further comprises the steps of:

a) identifying whether each defect is a repairable defect; and

b) repairing each repairable defect.

3. A method of fabricating a track as claimed in claim 1 or claim 2, wherein the step of calculating the optimal path includes calculating a number of different paths to optimise the performance of the coil track once defined in the layer and choosing the optimal path from the number of different paths.

4. A method of fabricating a track as claimed in claim 3, wherein the step of calculating the optimal path includes choosing from the number of different paths another path as the optimal path, if an unwanted inhomogneity develops in the calculation.

5. A method of fabricating a track as claimed in any preceding claims, wherein the step of calculating the optimal path includes computing a path that avoids, or bypasses, each weak area in the track that has an irreparable defect.

6. A method of fabricating a track as claimed in claim 5, wherein the step of calculating the optimal path includes coupling the other, non-weak, areas of the layer in series.

7. A method as claimed in any preceding claim, wherein the step of calculating the coil path comprises the step of adapting the path of the coil track such that the coil track produces a magnetic field that is predetermined..

8. A method as claimed in claim 7, wherein the step of adapting the coil path to rectify the shape of the field produced by the coil track also accounts for each field produced by each other existing coil track that comprises the coil.

9. A method as claimed in claim 7 or claim 8, wherein the step of adapting the coil path to rectify the shape of the field produced by the coil track also accounts for each field external to the coil.

10. A method as claimed in any preceding claim, further comprising the step of abandoning each part of the layer having too many defects to be repairable or avoidable, or that would be easier to abandon than to repair or to avoid.

11. A method as claimed in any preceding claim, wherein the scanning step comprises a plurality of probing steps, a different physical property of said material being probed during each probing step, each different physical property having a data set processable to form a map.

12. A method as claimed in claim 11, wherein each map is combined with one or more of the other maps to provide a composite map.

13. A method as claimed in claim 12, wherein each map is weighted relative to each other map when combined to provide the composite map.

14. A method as claimed in any preceding claim, the layer being a thin film of super-conducting material, and the step of scanning further comprising a step of testing whether said coil track superconducts.

15. A method as claimed in claim 14, wherein the step of testing uses a binary search method thereby locating a part of the coil track that does not have predetermined superconducting properties.

16. A method as claimed in claim 15, wherein the binary search method uses contact brushes which are moved in an iterative procedure to locate the or each defective area.

17. A method as claimed in claim 16, wherein the binary search method uses a probe to perturb the superconductive properties locally.

18. A method as claimed in claim 17, wherein the step of testing uses a probe spot method thereby locating a part of the coil track that does not have predetermined superconducting properties.

19. A method as claimed in claim 14, wherein the step of testing uses a dynamic testing techniquelocating a part of the coil track that is non-superconductive, the dynamic testing technique being dependent on at least one dynamic variable.

20. A method as claimed in claim 19, wherein at least one of the dynamic variables is the speed of rotation of the former divided by the probe repetition frequency.

21. A method as claimed in any one of claims 14 to 21, further comprising the step of producing a result from the step of testing whether the coil track superconducts, the result being portrayable as a map of the coil track, the map indicating each part of the

coil track that has poor superconducting properties, and the location of the or each part on the coil track.

22. A method as claimed in claim 21, further comprising the step of abandoning a part of the coil track that has poor superconducting properties.

23. A method as claimed in claim 22, further comprising the step of interconnecting those parts of the coil track that are not abandoned.

24. A method as claimed in any of claims 21 to 23, further comprising the step of repairing a part of the track that has poor superconducting properties.

25. A method as claimed in any one of claims 1 to 13, wherein the layer is a buffer layer or a metallisation layer.

26. A method as claimed in claim 25, wherein the coil track is formed in a subsequent layer.

27. A method as claimed in any preceding claim, wherein the former defines a substantially right circular cylindrical surface and the coil path defines a substantially spiral track about the former.

28. A method as claimed in any of the preceding claims, wherein the step of defining the coil track includes writing or patterning a path in the layer.

29. A method as claimed in any of the preceding claims, further comprising the step of depositing, shaping and texturing the material comprising the layer to form the track by defining the path, in situ, on, or in, the surface of the former.

30. A computer program or suit of computer programs arranged such that, when executed by a computer that is connected to, and arranged to control, an apparatus for forming a track in a layer of a thin film material for use in a superconducting coil, the

computer program or the suit of computer programs control the computer to perform the method of any of the preceding claims.

31. A computer-readable storage medium storing the computer program, or at least one of the suit of computer programs, of claim 30.

32. Apparatus for fabricating a track in a layer of thin film material for use in a super-conducting coil, the apparatus being arranged to carry out the method as claimed in any one of claims 1 to 29.

33. A method of fabricating a track formed in a layer of thin film material for use in a super-conducting coil, the layer provided on a former having a substantially curved surface, the method comprising the following steps:

a) depositing, shaping and texturing the material comprising the layer; and

b) forming the coil track as claimed in claims 1 to 29.

34. Apparatus for fabricating a track, the track being formed in a layer of thin film material for use in a superconducting coil, the layer provided on a former having a substantially curved surface, the track thereby being defined by a path being defined into or onto the layer,the apparatus comprising:

a) a scanner for scanning the layer to detect defects in the layer, the scanner comprising a probe for probing a physical characteristic of the material, the probe being arranged to transmit a signal comprising a data set of said physical property;

b) a memory for storing data;

c) a processor connected to the memory and the scanner, the processor being arranged:

(1) to control the probe and to receive the signal transmitted by the probe;

(2) to process the signal thereby extracting said data set;

(3) to process said data set to form a map having features indicating variations in said physical property over the layer;

(4) to analyse the features of said map to identify and locate each defect in the layer;

(5) to identify each defect that is irreparable;

(6) to calculate an optimal coil path so as to avoid the irreparable defect(s); and

(7) to direct the data set and the map to the memory for storage;

d) a coil writer being connected to the processor, the processor being arranged to control the coil writer to define the optimal coil path into or onto the layer, defining said coil track.

35. Apparatus as claimed in claim 34, further comprising a repairer, the repairer being connected to the processor, the processor being arranged to identify those defects that are repairable and to control the repairer to repair the reparable defects.

36. Apparatus as claimed in either claim 34 or 35, wherein the processor is arranged:

(1) to calculate the optimal path in order to abandon each part of the layer having too many defects to be repairable or avoidable, or each part that would be more easily abandoned than repaired or avoided; and

(2) to control the coil writer to interconnect those parts of the layer not abandoned.

37. Apparatus as claimed in any of claims 34 to 36, wherein the processor is arranged to adapt the calculation of the optimal path such that the coil track produces a magnetic field that is predetermined.

38. Apparatus as claimed in any one of claims 34 to 37, the layer being a thin film of superconducting material, the scanner comprising a coil tester, the processor connected to the coil tester and being arranged to control the coil tester, wherein the processor controls the coil tester to locate weakly superconducting areas of the coil track by using a probe test or an electrical test or a combination of both, and the processor calculates the optimal path in order to abandon a part of the coil that has poor superconducting properties.

39. Apparatus as claimed in any of claims 34 to 38, wherein the scanner:

(1) comprises a plurality of probes, each probe arranged to detect a different physical property of said material, and create a different data set; and

(2) transmits said data set to the processor, the processor being arranged:

(a) to process each data set to form a map of the variations of the corresponding material properties of the layer; and

(b) to combine one or more of the maps of different physical properties to provide a composite map.

40. Apparatus as claimed in any one of claims 34 to 39, wherein the layer is a buffer layer or a metallisation layer.

41. Apparatus for fabricating a track formed in a layer of thin film material for use in a superconducting coil, the layer provided on a former having a substantially curved surface, the apparatus comprising:

a) a deposition device being arranged to deposit, shape and texture the layer, in situ, on the surface of the former; and

b) apparatus being arranged to form the track the layer, the apparatus being claimed in any one of claims 34 to 39.

42. A device fabricated by way of a method, the method as claimed in any one of claims 1 to 29.

43. A method of fabricating a track in a layer of thin film material for use in a superconducting coil, the layer provided on a former having a substantially curved surface, the method comprising the steps of:

(i) scanning the layer to detect defects in the layer by probing a physical property of the material comprising the layer, before the coil path being defined in the layer to provide a data set of said physical property;

(ii) processing the data set to form a map, having features indicating variations in the said physical property over the layer;

(iii) analysing the features of the map to identify and locate defects in the layer;

(iv) identifying whether each defect is irreparable;

(v) calculating a number of coil paths so as to avoid the irreparable defect(s);

(vi) choosing one of the coil paths as an optimal path; and

(vii) writing or patterning the optimal path in the layer to define the coil track.

electrical device or machine of which the coil being fabricated is intended to form part. These other coils are or will be adjacent to, and in the vicinity of, the coil being fabricated.

A layer is a single deposition of a film, preferably a thin film, on the surface of the former (for the deposition of the initial layer), or the surface of the topmost layer on the former (for the deposition of subsequent layers).

A path or coil path is a route around which calculations are made in order to define the best optimised track for the superconducting coil. Thus it is a virtual track.

Patterning is the removing or adding of material in a specific geometry, including the defining of a path in a layer.

Printing is writing in parallel.

Texture is the physical appearance in terms of roughness and shape of surface features; in microscopical examination it relates to microstructural features such as grain shape, distribution of phases, grain boundary characteristics and crystallographic orientation. It is, more specifically in this application, crystallographic texture or preferred crystallographic orientation. In relation to superconducting materials, the texture of a sample of superconducting material is indicative of the superconducting properties of that sample. Generally, the texture of a material, such as the texture of a thin film superconductor, is detected by way of x-ray or neutron diffraction, electron back scattering diffraction, and other techniques that use an electron beam, such as an electron microscope. A further technique is RHEED (Reflection High Energy Electron Diffraction).

Texturing is copying into a layer the texture of an underlying layer or, in the case of an initial layer, it is the growing of a textured film.

A track is a coil path defined into a superconducting layer.

A turn is a single loop around a former having a substantially curved surface.

A weak area, also known as a bad area, is an area which falls below a threshold of a required property.

A winding is a single coil track and, in the context of this specification, it is not formed by a physical winding process.

Writing is geometrically, locally defining a path or a track, by the laying down or removal of material. Writing can include: etching, scribing and lithographic methods.